How can dynamic pricing models be successfully implemented into digital marketplaces to benefit SMEs in Kazakhstan?

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Abstract

The increased popularity of digital marketplaces caused many SMEs to start their online journey. However, the lack of systematisation and optimisation means that SMEs are often unproductive and do not fulfil their potential. This is worsened by the cost complexity of import-focused pricing, which is caused by local market conditions and the swift nature of digital marketplaces. The Kazakhstani market is rapidly developing; however, it is relatively unstable for SMEs. The price complexity issue can be solved by developing dynamic pricing models based on regional contexts. This study created an optimisation model with a macroeconomic focus through data analysis of key economic factors in Kazakhstan. The final dynamic pricing model focused on inflation, exchange rates and product demand.

Introduction

With rapid digitalisation, consumers increasingly refer to online services instead of offline experiences. Comfortable online shopping platforms such as digital marketplaces and online retailers are gaining and establishing popularity. However, while consumers are increasingly interested in online commerce, digitalisation among businesses is slowed down by volatile and unpredictable economic circumstances in emerging markets, causing them to lose time and possible profits.

One of the common struggles in online commerce is the price-setting process. E-commerce is known for its prompt nature, with selling being automated and accelerated. That often causes demand and supply jumps and creates a struggle regarding price setting. Many established digital marketplaces, such as Amazon, help businesses operating on their basis set dynamic prices with their pre-made models and thus provide immense help to SMEs.

Dynamic pricing is a profit and pricing management strategy in which an enterprise sets flexible and elastic product or service prices. In the context of digital marketplaces, dynamic pricing is widely used to control and monetise customer demand with regard to supply and storage. However, it is a common misconception that dynamic pricing only focuses on customer behaviour. The various models used by digital marketplaces vary depending on region, local

economic and governmental policies, proximity to the supplier and other factors. In emerging markets and economies, the primary focus of the models must be economic indicators such as inflation and export and import rates since they were found to influence the pricing the most (Raymond et al., 2001).

The literature on dynamic pricing models in emerging markets is scarce; the factors behind the models often need to be clarified. That causes local and international marketplaces in Kazakhstan to struggle with developing pricing models and often disregard the overall pricing issue entirely. However, online retailers such as Wildberries and Ozon recently started introducing dynamic pricing models based on customer behaviour and general costs.

While customer demand is inadvertently the focus of most dynamic pricing models, other implications exist in developing and emerging markets. This study aims to rethink the factors included in dynamic pricing models in digital marketplaces and make the indicators and conditions of the Kazakhstani economy the primary focus to help SMEs achieve maximum profitability.

Literature review

Dasgupta et al. (2009, pp. 393–400) discuss various algorithms for dynamic pricing in digital markets and emphasise that e-commerce focuses on maximising profit. The study focuses on two main algorithms: buyer attribute-prediction algorithm and derivative-following algorithm — the former acts as a cluster constructor, which groups the buyers depending on their decisions and preferences. It can adapt to changing buyer preferences and personalise pricing. While the proposed algorithm focuses on customer preferences, Dasgupta et al. (2009, pp. 393–400) mention the importance of cultural norms and local customer behaviour when implementing the algorithms. Overall, the discussed algorithm could help systematise the available data and maximise profitability for SMEs.

Implementing dynamic pricing models for Kazakhstani SMEs might be more complex because the market has yet to be entirely or even partially digitalised, and dynamic pricing models rely heavily on digitalisation. Yezhebay et al. (2021) highlight the low level of digital maturity among Kazakhstani SMEs; in the article, they investigate the dimensions and levels of digital maturity among Kazakhstani enterprises. Yezhebay et al. (2021) pinpoint economic vulnerability and low digitalisation returns as significant obstacles to the further digitalisation of Kazakhstani SMEs. While the proposed model lacks information on pricing decisions, it discusses the importance of data analysis of SME performance and economic conditions.

Using panel data from 2010-2016 on SMEs, Maratkyzy (2018) found that international trade indicators significantly affect Kazakhstani SME productivity. The labour productivity of exporting firms is higher than that of non-exporting firms, and even though mining dominates

the exporting market in Kazakhstan, it still benefits local SMEs. International trade indicators explain more than two-thirds of labour productivity in the regions (Maratkyzy, 2018). The other principal determinants of SME development in Kazakhstan were government policies, such as financial assistance provided to SMEs. Overall, the success of Kazakhstani SMEs is said to depend heavily on support from primary industries and government financing.

Cosguner (2013) explores the implementation of dynamic pricing models in the presence of inertial demand in the manufacturing industry. The study found that while customer demand and inertia inevitably have implications on pricing in dynamic models, they are not critical to exclude if the dynamic pricing model focuses on econometric factors rather than internal demand. (add more)

Furthermore, Klapper and Zenetti (2012, pp. 379-400) elaborate on various algorithms used in dynamic pricing. They mention that state dependence lowers price elasticity, although inertia and customer loyalty usually improve profits. Results of the study indicate that retailers must initially set lower prices to build loyalty; however, with time, increasing prices and keeping a higher plank could allow for greater price elasticity. Klapper and Zenetti (2012) stress the importance of including state dependence, inertia and customer loyalty in the craft of a dynamic pricing model since they significantly affect customer choices.

Dynamic pricing models are often criticised for exploiting customer interest and lack of agency; however, in developing and emerging markets, it is necessary to adjust pricing with regard to local economic and policy conditions (Raymond et al., 2001). In their study, Raymond et al. (2001) examine cost complexity factors and export firms' pricing decisions in emerging markets. By comparing U.S. and Korea-based firms, they identify inflation as the most influential factor. Overall, Raymond et al. (2001) stress the importance of price elasticity in developing economies due to the constantly changing state of the market.

Rousset et al. (2018) describe dynamic pricing models' ethical implications and consumer opinions. ODP parameters such as stock levels, market conditions and inflation rates are perceived as more ethical. Other parameters, such as consumer data and behaviour, were considered less ethical and often opened conversations on price gauging. Nunan and Domenico (2022) further discuss the various factors of ethical implementation of dynamic pricing. In the study, differential pricing is the most significant complaint among customers. Lack of transparency causes customers to feel misled or manipulated if they are unaware of the factors influencing the pricing. This further erodes trust between firms and customers (Nunan & Domenico, 2022).

Methodology

This study focused on developing a dynamic pricing model with a macroeconomic emphasis. This was achieved by running data analysis with the ARIMA model on historical data, examining available predicted economic trends, and adjusting an optimisation model with additional flexibility for the forecasted results.

Data Collection

Historical data was gathered from primary public sources such as the National Bureau of Statistics and the National Bank of the Republic of Kazakhstan (NBRK). Data sets such as CPI, WPI, inflation, and exchange rates were used in data analysis. CPI (Consumer Price Index) was used to simplify the calculation of the effect of the inflation rates on pricing; the 'Goods and Services' section was primarily used in ARIMA analysis. WPI (Wholesale Prices Index) was used to forecast the production costs and account for flexibility in the final model. Inflation rates were gathered from NBRK, including short-term predictions to compare with the forecasted Consumer Price Indices. The exchange rates forecasts focused on Kazakhstani Tenge - U.S. Dollar and Kazakhstani Tenge - Chinese Yuan rates. The data sets were selected due to their importance as economic indicators which affect SMEs' pricing in Kazakhstan.

Time Series Forecasting

The ARIMA (AutoRegressive Integrated Moving Average) model was selected due to its flexibility in forecasting and computational simplicity. Its nature makes it well-suited for forecasting the non-stationarity of economic data, making it ideal for predicting markers such as inflation rates, CPI rates, and exchange rates.

The selected data sets were first adjusted to suit ARIMA model analysis. Then, using ACF (autocorrelation function) and PACF (partial autocorrelation function), short-term and long-term trend predictions were produced. The ARIMA-generated forecasts were compared to NBRK's pre-made forecasts to ensure the model's reliability.

Price Optimisation Model

Using ARIMA-analysis forecasts and historical trends, the dynamic pricing model was developed to determine optimal pricing strategies for SMEs operating on digital marketplaces in Kazakhstan. This model's objective was to maximise profits by overviewing macroeconomic indicators, the local economic climate, and product demand. The model integrates the forecasted inflation, WPI and exchange rates and includes demand flexibility due to the robust nature of digital marketplaces. Inflation rates were added to ensure productive output, and exchange rates were considered due to their importance in import-focused businesses' pricing. The model was further tested on the economic forecasts and historical data to inspect its ability to adjust to local conditions. This was done to ensure the robustness of the model.

Dynamic Pricing Model

Data Analysis Results

The CPI forecasts (fig.1) indicated that there will be a constant short-term and long-term increase in prices and stable inflation. However, the ARIMA model suggested that inflation will happen at a slower, more stable rate. This aligned with the National Bank of the Republic of Kazakhstan's predictions and overall trends worldwide. The forecasted wholesale price indices (WPI) (fig.2) showcased instability, with high and drastic fluctuations. Thus, the pricing model was adjusted to reflect and adapt to the fluctuations. Finally, the exchange rate forecasts (fig.3) showed a rise in the next three years without drastic fluctuations. The model's development included the exchange rate forecasts due to the high importing culture in digital marketplaces.

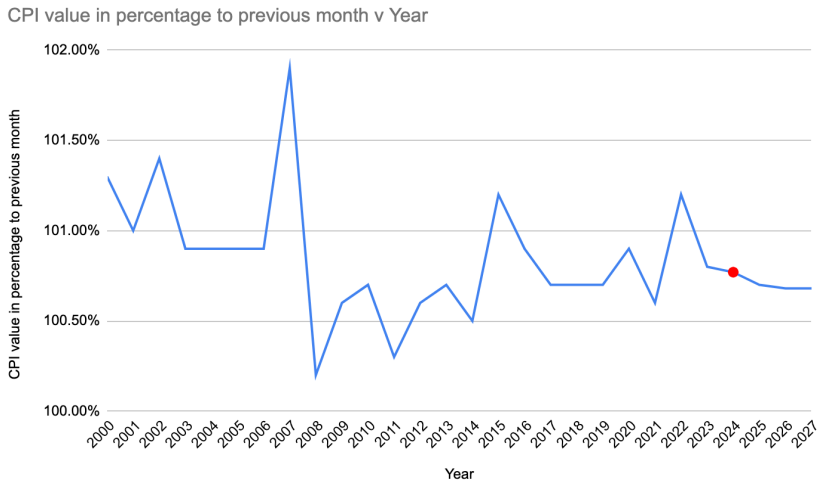

Figure 1 - CPI value in percentage

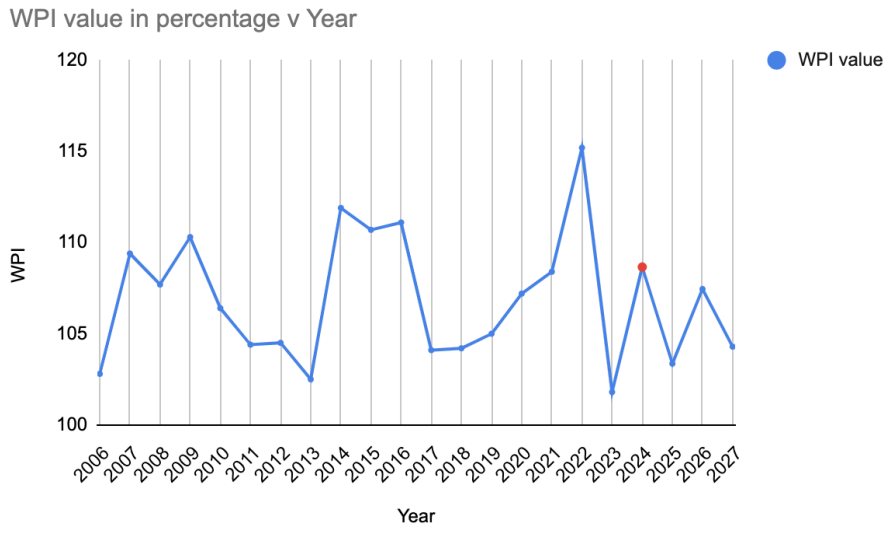

Figure 2 - WPI value in percentage

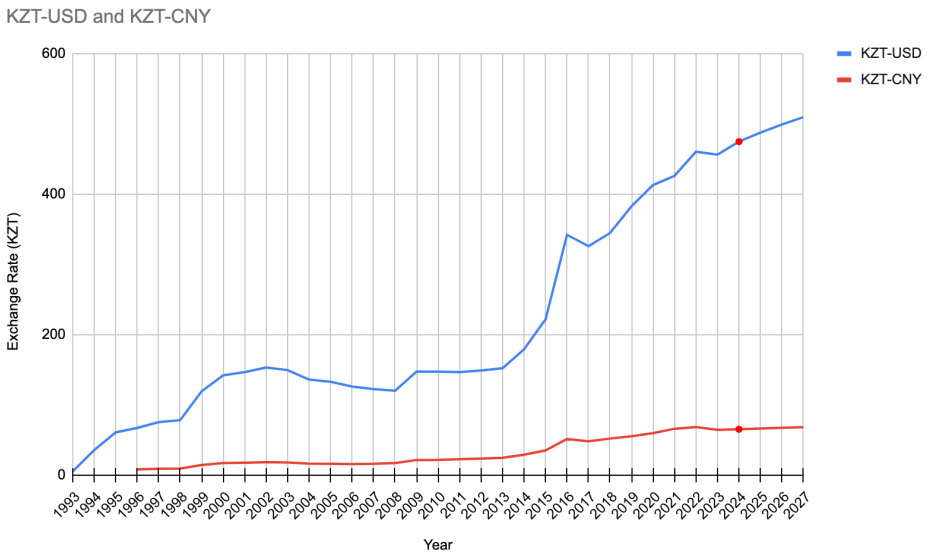

Figure 3 - Exchange rate in Kazakhstani Tenge to U.S. Dollar and Chinese Yuan

Dynamic Pricing Model

$$P_t = P_{t-1} \times (1 + \alpha_t \times Infl_t) \times (1 + \beta \times \frac{ER_t - ER_{t-1}}{ER_{t-1}}) \times (1 + \gamma \times \frac{D_t - D_{t-1}}{D_{t-1}})$$

Where P_t is the price of the product at a time t, P_{t-1} is the price of the product at the previous time step, $Infl_t$ is the inflation rate at a time t, β is sensitivity to exchange rate, ER_t is the exchange rate at a time t, γ is sensitivity to demand, D_t is demand for the product at a time t and α_t is $\alpha_1 \times (1 + \delta \times \frac{WPI_t - WPI_{t-1}}{WPI_{t-1}})$

Where α_1 is base sensitivity to inflation, δ is the scaling factor and WPI_t is Wholesale Price Index is at the time t.

Discussion

The pricing model incorporates inflation and exchange rates, which significantly determine the pricing strategies of small and medium-sized enterprises (SMEs). This integration is crucial due to the interconnectedness of these factors and their collective impact on the business environment. Moreover, the model provides the requisite flexibility to accommodate variations in demand and Wholesale Price Index (WPI), particularly in light of the inherent volatility of digital marketplaces and fluctuating exchange rates. These dynamic economic conditions necessitate a tailored approach to address the evolving nature of the economic environment in Kazakhstan, which is characterised by rapid fluctuations and sustained growth.

Limitations and Future Opportunities

The research was conducted over a short period, limiting data analysis to simple models such as ARIMA. In the future, with more computational power and time, more complex data analysis models could be run. Machine learning, Q-learning, and DBN (Dynamic Bayesian Networks) could be conducted to ensure the reliability and accuracy of the forecasted results.

Furthermore, due to a lack of pricing data among SMEs operating on digital marketplaces, the model was not tested on real-time pricing data to measure its robustness. This caused potential mistakes and a more significant margin of error. Data was not found on publicly available resources and databases, thus not included in the research. In the field of pricing in emerging markets such as Kazakhstan, first-hand data may be more reliable and the only option due to little research on pricing.

The overall under-research nature of the area made literature review, data gathering and analysis, and model development less sophisticated. However, it opened up more pathways for future research and data collection.

Conclusion

Dynamic pricing is a viable and efficient solution, especially for SMEs struggling to navigate the rapid nature of digital marketplaces. The economic challenges and volatile circumstances of the Kazakhstani market offer more opportunities for development and innovation of more advanced and nuanced pricing models.

The developed model is well suited for Kazakhstan's growing and somewhat unstable economy; it is tailored to local economic circumstances and is relatively simple to adapt to the limited resources available to SMEs. It also provides an algorithmic solution to the pricing dilemma, which aligns with the nature of E-commerce. That allows the model to be integrated into digital marketplaces to benefit SMEs in Kazakhstan.

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